ACC/AHA 2004 Guideline Update for Coronary Artery Bypass Graft Surgery: Summary Article

A Report of the American College of Cardiology/American Heart Association Task Force on Practice Guidelines (Committee to Update the 1999 Guidelines for Coronary Artery Bypass Graft Surgery)

Developed in Collaboration With the American Society for Thoracic Surgery and the Society of Thoracic Surgeons

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Introduction and Methodology

The American College of Cardiology (ACC)/American Heart Association (AHA) Task Force on Practice Guidelines regularly reviews existing guidelines to determine when an update or full revision is needed. This process gives priority to areas where major changes in text, particularly recommendations, are mentioned on the basis of new understanding of evidence. Minor changes in verbiage and references are discouraged. The ACC/AHA Guidelines for Coronary Artery Bypass Graft Surgery published in 1999 have now been updated. The

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The ACC/AHA Task Force on Practice Guidelines makes every effort to avoid any actual or potential conflicts of interest that might arise as a result of an outside relationship or personal interest of a member of the writing panel. Specifically, all members of the writing panel are asked to provide disclosure statements of all such relationships that might be perceived as real or potential conflicts of interest. These statements are reviewed by the parent task force, reported orally to all members of the writing panel at the first meeting, and updated as changes occur. The relationship with industry information for the writing committee members is posted on the ACC and AHA World Wide Web sites with the full-length version of the update, along with the names and relationships with industry of the peer reviewers.

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Copies: This document and the full-text guidelines are available on the World Wide Web sites of the American College of Cardiology (www.acc.org) and the American Heart Association (www.americanheart.org). To obtain a single copy of this summary article published in the September 1, 2004, issue of the *Journal of the American College of Cardiology* or the August 31, 2004, issue of *Circulation*, call 1-800-253-4636 or write to the American College of Cardiology Foundation, Resource Center, 9111 Old Georgetown Road, Bethesda, MD 20814-1699, and ask for reprint number 71-0281. To purchase additional reprints: up to 999 copies, call 1-800-611-6083 (US only) or fax 413-665-2671; 1000 or more copies, call 214-706-1789, fax 214-691-6342, or e-mail pubauth@heart.org.

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full-text guidelines incorporating the updated material are available on the Internet (www.acc.org or www.americanheart.org) in both a version that shows the changes from the 1999 guidelines in track changes mode, with strike-through indicating deleted text and underlining indicating new text, and a "clean" version that fully incorporates the changes. This article describes the major areas of change reflected in the update in a format that we hope can be read and understood as a stand-alone document. Please note we have changed the table of contents headings in the 1999 guidelines from roman numerals to unique identifying numbers. Interested readers are referred to the full-length Internet version to completely understand the context of these changes.

Classification of Recommendations and Level of Evidence are expressed in the ACC/AHA format as follows:

Classification of Recommendations

Class I: Conditions for which there is evidence and/or general agreement that a given procedure or treatment is useful and effective.

Class II: Conditions for which there is conflicting evidence and/or a divergence of opinion about the usefulness/efficacy of a procedure or treatment.

IIa: Weight of evidence/opinion is in favor of usefulness/efficacy.

IIb: Usefulness/efficacy is less well established by evidence/opinion.

Class III: Conditions for which there is evidence and/or general agreement that the procedure/treatment is not useful/effective and in some cases may be harmful.

Level of Evidence

Level of Evidence A: Data are derived from multiple randomized clinical trials or meta-analyses.

Level of Evidence B: Data are derived from a single randomized trial, or nonrandomized studies.

Level of Evidence C: Only consensus opinion of experts, case studies, or standard of care.

(Please refer to Table 1 in the full-text guidelines for more details.)

Modification I

3.1.3. Morbidity Associated With CABG: Adverse Cerebral Outcomes

4.1.1.1.1. Aortic Atherosclerosis and Macroembolic Stroke

New material was added on off-pump coronary artery bypass (OPCAB) and its role in neurological outcomes after CABG. The material is reproduced below:

OPCAB avoids both aortic cannulation and cardiopulmonary bypass. Accordingly, one would expect postoperative neurological deficits to be reduced in patients undergoing OPCAB. Three randomized controlled trials[1–3] have not firmly established a significant change in neurological outcomes between OPCAB patients and conventional CABG patients. Each trial demonstrates problems inherent with small patient cohorts, differing definitions, and patient selection. At this point, there is insufficient evidence of a difference in neurological outcomes for patients undergoing OPCAB compared with those undergoing conventional CABG.[4]

Modification II

3.3.2.2. Long-Term Outcome

New material was added with clinical trial data comparing stents with CABG in patients with multivessel disease. Table 11 was revised to incorporate stent trial data and outcomes at longer follow-up. The new text appears below:

Comparison with stents

Since the previous update of these guidelines, several trials comparing stents with CABG in patients with multivessel disease have been initiated. The Arterial Revascularization Therapies Study Group (ARTS) trial enrolled 1205 patients with multivessel coronary disease in whom a cardiac surgeon and interventional cardiologist agreed that they could achieve a similar extent of revascularization. In this randomized comparison, there was no difference at 1 year in the combined rate of death, myocardial infarction (MI), and stroke between the 2 revascularization strategies.[5] However, repeat revascularization rates were higher with stenting (16.8% versus 3.5% with surgery), with a net cost savings of $2973 per patient favoring the stent approach. In patients with diabetes (n equals 198), the difference in repeat revascularization rates was even more disparate (22.3% with stents versus 3.1% with CABG), although overall event-free survival was similar[6] (Table 11).

Similar results were reported by the Stent or Surgery (SoS) trial investigators. The trial randomized 988 patients with multivessel disease (57% 2-vessel; 42% 3-vessel) to revascularization with percutaneous coronary intervention (PCI) (78% received stents) or CABG (81% with pedicled left internal mammary artery [IMA] graft). The primary end point of repeat revascularization occurred in 21% of PCI patients versus 6% of CABG patients at a median follow-up of 2 years (hazard ratio equals 3.85, P less than 0.0001). Freedom from angina was also better with surgery (79% versus 66%). Mortality was higher in the PCI group but was influenced by a particularly low surgical mortality and a high rate of noncardiovascular death in the PCI group.[7]

In the Angina With Extremely Serious Operative Mortality Evaluation (AWESOME) study, 454 patients at 16 VA hospitals with high-risk features for adverse outcome with surgery were randomized to either surgery or PCI. High-risk characteristics included prior open-heart surgery, age greater than 70 years, ejection fraction less than 0.35, MI within 7 days, and the need for an intra-aortic balloon pump (IABP). Stents were used in 54% of PCI patients. Survival was similar (79% with CABG and 80% with PCI) at 36 months.[8] Finally, in the Stenting versus Internal Mammary Artery (SIMA) trial, 121 patients with isolated proximal left anterior descending coronary artery disease were randomly treated with stenting or CABG (using the IMA). At 2.4 years of follow-up, there were no differences in the rates of death, MI, functional class, medications, or quality of life. Repeat revascularization was

TABLE 11. CABG vs PCI: Randomized Controlled Trials

				Acute Outcome, %			Late Outcome, %						
Trial (Ref)	Age, y (% Female)	CAD	N	Death: CABG PCI	QW-MI: CABG PCI	Hosp CABG	Death	QW-MI	Angina	RR, % (Total/PCI/CABG)	Primary End Point	Primary End Point, %	F/U, y
PTCA trials													
BARI[18]	61 (26%)	MV	1829	1.3	4.6	N/A	15.6¶	19.6	N/A	8/7/1	D	15.6¶	8§
				1.1	2.1	6.3	19.1¶	21.3	N/A	54/34/31		19.1¶	
EAST[19]	61 (26%)	MV	392	1	10.3	N/A	17	19.6	12	13/13/1	D+MI+T	27.3	8‖
				1	3.0†	10.1	21	16.6	20†	54/41/22		28.8	
GABI[20]	N/A (20%)	MV	359	2.5	8	N/A	6.5	9.4	26	6/5/1	A	26	1
				1.1	2.3†	8.5	2.6	4.5	29	44/27/21		29	
Toulouse[21]	67 (23%)	MV	152	1.3	6.6	N/A	10.5	1.3	5.3	9/9/0	A	5.2	5
				1.3	3.9	3.9	13.2	5.3	21.1†	29/15/15		21.1†	
RITA[22]	57 (19%)	SV+MV*	1011	1.2	2.4	N/A	3.6	5.2	21.5	4/3/1	D+MI	8.6	2.5‡
				0.8	3.5	4.5	3.1	6.7	31.3†	31/18/19		9.8	
ERACI[23]	58 (13%)	MV	127	4.6	6.2	N/A	4.7	7.8	3.2	6/3/3	D+MI+A+RR	23	3
				1.5	6.3	1.5	9.5	7.8	4.8	37/14/22		53†	
MASS[24]	56 (42%)	SV (LAD)	142	1.4	1.4	N/A	N/A	N/A	2	0/0/0	D+MI+RR	3	3
				1.4	0	11	N/A	N/A	18	22/29/14		24†	
Lausanne[25]	56 (20%)	SV (LAD)	134	0	0	N/A	1.5	1.5	5	3/3/0	D+MI+RR	7.6	2‡
				0	0	2.9	0	2.9	6	25/12/13		36.8†	
CABRI[26]	60 (22%)	MV	1054	1.3	N/A	N/A	2.7	3.5	10.1	9/6/1	D	2.7	1
				1.3	N/A	N/A	3.9	4.9	13.9†	36/21/18		3.9	
Stent trials													
SoS[7]	61 (21%)	MV	988	N/A	N/A	N/A	2	8	21	6/4/1	RR	6	1
							5†	5	34†	21†/13/9		21†	
ERACI II[16]	62 (21%)	MV	450	N/A	N/A	N/A	8	6	8	5/0/0	D+MI+CVA+RR	19	1.6
							3†	3†	15†	17†/0/5		23	
ARTS[5]	61 (24%)	MV	1205	N/A	N/A	N/A	3	5	10	4/3/1	D+MI+CVA+RR	12	1
							3	6	21†	21†/16/7		26†	
AWESOME[8]	67 (N/A)	MV	454	N/A	N/A	N/A	N/A	N/A	N/A	N/A	D	21	3
												20	
SIMA[9]	59 (21%)	SV	121	N/A	N/A	N/A	4	4	5	0/0/0	D+MI+RR	7	2.4
							2	5	9	24†/13/6		31†	
LEIPZIG[17]	62 (25%)	SV	220	N/A	N/A	N/A	2	5	21	8/8/0	D+MI+RR	15	0.5
							0	3	38†	29/25/4		31†	

CABG indicates coronary artery bypass graft; PCI, percutaneous coronary intervention; CAD, coronary artery disease; QW, Q wave; MI, myocardial infarction; Hosp CABG, required CABG after PCI and before hospital discharge; RR, repeated revascularization; F/U, follow-up; BARI, Bypass Angioplasty Revascularization Investigation; EAST, Emory Angioplasty Surgery Trial; GABI, German Angioplasty Bypass-surgery Investigation; RITA, Randomized Intervention Treatment of Angina; ERACI, Estudio Randomizado Argentino de Angioplastia vs Cirugia; MASS, Medicine, Angioplasty, or Surgery Study; CABRI, Coronary Angioplasty versus Bypass Revascularization Investigation; SoS, the Stent or Surgery trial; ERACI II, Coronary Angioplasty with Stenting vs Coronary Artery Bypass in patients with MV disease; ARTS, Arterial Revascularization Therapies Study; AWESOME, Angina With Extremely Serious Operative Mortality Evaluation; SIMA, Stenting vs Internal Mammary Artery; LEIPZIG, Stenting vs Minimally Invasive Bypass Surgery; MV, multivessel; D, death; N/A, data not available; T, thallium defect; A, angina; SV, single vessel; and LAD, left anterior descending coronary artery.

*Included total occlusion.

†*P* is less than 0.05 comparing CABG and PCI cohorts.

‡Planned 5-year follow-up (interim results).

§Primary end point and mortality at 8 years, other end points at 5 years.

‖Primary end point and mortality at 8 years, other end points at 3 years.

¶Statistically significant.

required more often (31% versus 7%) in the stent group.[9] Overall, 6 trials have now been published comparing CABG with PCI utilizing stents in single or multivessel disease. Compared with the earlier trials utilizing balloon angioplasty, stent usage and left IMA revascularization rates have increased.[16–26] The results in terms of death, MI, and stroke are similar in the more recent trials; however, the disparity in the need for repeat revascularization, which favors surgery, has narrowed (Table 11).

Modification III

4.1.2.4. Cardiac Biomarker Elevation and Outcome

This section was added to reflect current understanding of the prognostic value of cardiac biomarkers when assessed after CABG.

Modification IV

4.2.3. Hormonal Manipulation

Although more than 30 observational studies showed a reduced mortality for coronary disease in postmenopausal women taking hormone therapy, hormone replacement is no longer recommended for women undergoing CABG surgery. The new material can be found in the full-text guidelines.

Modification V

5.7. Reoperation

The section on reoperation was rewritten to include emerging understanding of the nature and sequelae of late vein graft atherosclerosis. In patients in whom late vein graft stenosis is found in vein grafts supplying the LAD coronary artery, reoperation should be strongly considered to improve survival. The need for reoperation may be reduced as surgeons increasingly utilize arterial conduits for the primary revascularization. Please see the full-text guidelines for new material.

Modification VI

5.11. CABG in Acute Coronary Syndromes

New text was added regarding the risk of CABG in acute coronary syndrome patients treated with new and more potent antithrombotic and antiplatelet therapies. This update reflects more recent nomenclature that defines the spectrum of acute coronary syndromes from unstable angina to non–ST-segment elevation MI to ST-segment elevation MI. Where appropriate, the writing committee used the new classification in the document, recognizing, however, that many of the cited trials categorized the patient subgroups according to the older nomenclature. The new text is reproduced below.

A new issue that has arisen concerns the risk of CABG in patients with acute coronary syndrome treated with new and more potent antithrombotic and antiplatelet therapies. Several studies have demonstrated a greater risk for postoperative hemorrhage in patients treated with low-molecular-weight heparin,[10,10a,10b] abciximab,[11] and clopidogrel.[12] It is important to understand the pharmacokinetics of these agents to reduce the risk. For instance, no increased bleeding was observed when the short-acting glycoprotein IIb/IIIa inhibitor eptifibatide was discontinued at least 2 hours before bypass,[13] when platelet transfusions were appropriately administered after abciximab,[14] and when clopidogrel was withheld for 5 days before surgery.[12] In some instances, the need for surgery supersedes the risk.

Modification VII

6.1. Less-Invasive CABG

The section on less-invasive CABG was extensively rewritten to highlight advances in OPCAB with more recent clinical trial data. Please refer to the full-text guidelines for further details.

Modification VIII

6.1.1. Robotics

This new section was added to address the current understanding of robotic coronary bypass.

Modification IX

6.2. Arterial and Alternate Conduits

The Arterial and Alternate Conduits section was updated to include more recent trial data and explore the use of multiple IMA grafts (bilateral IMA, or BIMA).

Modification X

6.4. Transmyocardial Revascularization

This section was updated to include new prospective, controlled, randomized trials that demonstrate efficacy of transmyocardial revascularization (TMR) in select patients.

Modification XI

7.3. Hospital Environment

A new section on "Hospital Environment" was added to explain the process of clinical care surrounding CABG surgery and how appropriate implementation of clinical guidelines can show measurable improvement in outcomes.

Modification XII

The section "Areas in Need of Future Research" was eliminated because the material was covered in previous sections.

Modification XIII

All of the recommendations in the CABG guideline update were written in full sentences that express a complete thought, such that a recommendation, even if separated and presented apart from the rest of the document, would still convey the full intent of the recommendation. It is hoped that this will increase readers' comprehension of the guidelines. In the 1999 update, the committee did not rank the available scientific evidence in an A, B, or C fashion. The level of evidence for each recommendation is now provided. The rewritten recommendations appear under their respective headings below.

3.1.2. Predicting Hospital Mortality

Class IIa

1. It is reasonable to use statistical risk models to obtain objective estimates of CABG operative mortality. *(Level of Evidence: C)*

3.1.3. Morbidity Associated With CABG: Adverse Cerebral Outcomes

Class I

1. Significant atherosclerosis of the ascending aorta mandates a surgical approach that will minimize the possibility of arteriosclerotic emboli. *(Level of Evidence: C)*

4.1.1.1.2. Atrial Fibrillation and Postoperative Stroke

Class IIa

1. In post-CABG atrial fibrillation that is recurrent or persists more than 24 hours, warfarin anticoagulation for 4 weeks is probably indicated. *(Level of Evidence: C)*

4.1.1.1.3. Recent Anterior MI, LV Mural Thrombus, and Stroke Risk

Class IIa

1. Long-term (3 to 6 months) anticoagulation is probably indicated for the patient with recent anteroapical infarct and persistent wall-motion abnormality after coronary bypass. *(Level of Evidence: C)*

Class IIb

1. In patients having recent anterior MI, preoperative screening with echocardiography may be considered to detect left ventricular (LV) thrombus, because the technical approach and timing of surgery may be altered. *(Level of Evidence: C)*

4.1.1.1.6. Carotid Disease and Neurological Risk Reduction

Class IIa

1. Carotid endarterectomy is probably recommended before CABG or concomitant to CABG in patients with a symptomatic carotid stenosis or in asymptomatic patients with a unilateral or bilateral internal carotid stenosis of 80% or more. *(Level of Evidence: C)*
2. Carotid screening is probably indicated in the following subsets: age greater than 65 years, left main coronary stenosis, peripheral vascular disease, history of smoking, history of transient ischemic attack or stroke, or carotid bruit on examination. *(Level of Evidence: C)*

4.1.2.2. Myocardial Protection for Acutely Depressed Cardiac Function

Class I

1. Blood cardioplegia should be considered in patients undergoing cardiopulmonary bypass accompanying urgent/emergency CABG for acute MI or unstable angina. *(Level of Evidence: B)*

4.1.2.3. Protection for Chronically Dysfunctional Myocardium

Class IIa

1. Blood cardioplegia is probably indicated in patients undergoing cardiopulmonary bypass accompanying CABG in the presence of a chronically dysfunctional left ventricle. *(Level of Evidence: B)*

4.1.2.4. Cardiac Biomarker Elevation and Outcome

Class IIb

1. Assessment of cardiac biomarkers in the first 24 hours after CABG may be considered. Patients with the highest elevations of creatine kinase-MB (greater than 5 times upper limits of normal) are at increased risk of subsequent events. *(Level of Evidence: B)*

4.1.2.5. Adjuncts to Myocardial Protection

Class IIa

1. The use of a prophylactic intra-aortic balloon pump (IABP) as an adjunct to myocardial protection is probably indicated in patients with evidence of ongoing myocardial ischemia and/or patients with a subnormal cardiac index. *(Level of Evidence: B)*

4.1.2.7. Inferior Infarct with Right Ventricular Involvement

Class IIa

1. After infarction that leads to clinically significant right ventricular dysfunction, it is reasonable to delay surgery for 4 weeks to allow recovery. *(Level of Evidence: C)*

4.1.4. Reducing the Risk of Perioperative Infection

Class I

1. Preoperative antibiotic administration should be used in all patients to reduce the risk of postoperative infection. *(Level of Evidence: A)*
2. In the absence of complicating circumstances, a deep sternal wound infection should be treated with aggressive surgical debridement and early revascularized muscle flap coverage. *(Level of Evidence: B)*

Class IIa

1. The risk for deep sternal wound infection is reduced by aggressive control of perioperative hyperglycemia with a continuous, intravenous insulin infusion.[15] *(Level of Evidence: B)*

4.1.5. Prevention of Postoperative Arrhythmias

Class I

1. Preoperative or early postoperative administration of beta-blockers in patients without contraindications should be used as the standard therapy to reduce the incidence and/or clinical sequelae of atrial fibrillation after coronary bypass surgery. *(Level of Evidence: B)*

Class IIa

1. Preoperative administration of amiodarone reduces the incidence of postcardiotomy atrial fibrillation and is an appropriate prophylactic therapy for

patients at high risk for postoperative atrial fibrillation who have contraindications to therapy with beta-blockers. *(Level of Evidence: B)*
2. Digoxin and nondihydropyridine calcium channel blockers are useful for control of ventricular rate but at present have no indication for prophylactic use. *(Level of Evidence: B)*

Class IIb
1. Low-dose sotalol can be considered to reduce the incidence of atrial fibrillation after CABG in patients who are not candidates for traditional beta-blockers. *(Level of Evidence: B)*

4.2.1. Antiplatelet Therapy for SVG Patency

Class I
1. Aspirin is the drug of choice for prophylaxis against early saphenous vein graft (SVG) closure. It is the standard of care and should be continued indefinitely given its benefit in preventing subsequent clinical events. *(Level of Evidence: A)*

4.2.2. Pharmacological Management of Hyperlipidemia

Class I
1. All CABG surgery patients should receive statin therapy unless otherwise contraindicated. *(Level of Evidence: A)*

4.2.3. Hormonal Manipulation

Class III
1. Initiation of hormone therapy is not recommended for women undergoing CABG surgery. *(Level of Evidence: B)*

4.2.4. Smoking Cessation

Class I
1. All smokers should receive educational counseling and be offered smoking cessation therapy after CABG. *(Level of Evidence: B)*
2. Pharmacological therapy including nicotine replacement and bupropion (in select patients) should be offered to patients indicating a willingness to quit. *(Level of Evidence: B)*

4.2.5. Cardiac Rehabilitation

Class I
1. Cardiac rehabilitation should be offered to all eligible patients after CABG. *(Level of Evidence: B)*

5.6. Valve Disease

Class I
1. Patients undergoing CABG who have severe aortic stenosis (mean gradient greater than or equal to 50 mm Hg or Doppler velocity greater than or equal to 4 meters per second) who meet the criteria for valve replacement should have concomitant aortic valve replacement. *(Level of Evidence: B)*

Class IIa
1. For a preoperative diagnosis of clinically significant mitral regurgitation concomitant mitral correction at the time of CABG is probably indicated. *(Level of Evidence: B)*
2. In patients undergoing CABG who have moderate aortic stenosis and are at acceptable risk for aortic valve replacement (mean gradient 30 to 50 mm Hg or Doppler velocity 3 to 4 meters per second), concomitant aortic valve replacement is probably indicated. *(Level of Evidence: B)*

Class IIb
1. Patients undergoing CABG who have mild aortic stenosis (mean gradient less than 30 mm Hg or Doppler velocity less than 3 meters per second) may be considered candidates for aortic valve replacement if the risk of the combined procedure is acceptable. *(Level of Evidence: C)*

5.11. CABG in Acute Coronary Syndromes

Class I
1. If clinical circumstances permit, clopidogrel should be withheld for 5 days before the performance of CABG surgery. *(Level of Evidence: B)*

6.2. Arterial and Alternate Conduits

Class I
1. In every patient undergoing CABG, the left IMA should be given primary consideration for revascularization of the LAD artery. *(Level of Evidence: B)*

6.4. Transmyocardial Revascularization (refer to the TMR section of the Stable Angina Update)

Class IIa
1. Transmyocardial surgical laser revascularization, either alone or in combination with coronary artery bypass surgery, is reasonable in patients with angina refractory to medical therapy who are not candidates for PCI or surgical revascularization. *(Level of Evidence: A)*

9.2.1. Asymptomatic or Mild Angina

Class I
1. CABG should be performed in patients with asymptomatic ischemia or mild angina who have significant left main coronary artery stenosis. *(Level of Evidence: A)*
2. CABG should be performed in patients with asymptomatic ischemia or mild angina who have left main equivalent: significant (greater than or equal to 70%) stenosis of the proximal LAD and proximal left circumflex artery. *(Level of Evidence: A)*
3. CABG is useful in patients with asymptomatic ischemia or mild angina who have 3-vessel disease. (Survival benefit is greater in patients with abnormal LV function; eg, ejection fraction [EF] less than 0.50 and/or large areas of demonstrable myocardial ischemia.) *(Level of Evidence: C)*

Class IIa
1. CABG can be beneficial for patients with asymptomatic or mild angina who have proximal LAD stenosis with 1- or 2-vessel disease. (This recommendation becomes Class I if extensive ischemia is documented

by a noninvasive study and/or LVEF is less than 0.50.) *(Level of Evidence: A)*

Class IIb

1. CABG may be considered for patients with asymptomatic or mild angina who have 1- or 2-vessel disease not involving the proximal LAD. (If a large area of viable myocardium and high-risk criteria are met on noninvasive testing, this recommendation becomes a Class I.) *(Level of Evidence: B)*

9.2.2. Stable Angina

Class I

1. CABG is recommended for patients with stable angina who have significant left main coronary artery stenosis. *(Level of Evidence: A)*
2. CABG is recommended for patients with stable angina who have left main equivalent: significant (greater than or equal to 70%) stenosis of the proximal LAD and proximal left circumflex artery. *(Level of Evidence: A)*
3. CABG is recommended for patients with stable angina who have 3-vessel disease. (Survival benefit is greater when LVEF is less than 0.50.) *(Level of Evidence: A)*
4. CABG is recommended in patients with stable angina who have 2-vessel disease with significant proximal LAD stenosis and either EF less than 0.50 or demonstrable ischemia on noninvasive testing. *(Level of Evidence: A)*
5. CABG is beneficial for patients with stable angina who have 1- or 2-vessel CAD without significant proximal LAD stenosis but with a large area of viable myocardium and high-risk criteria on noninvasive testing. *(Level of Evidence: B)*
6. CABG is beneficial for patients with stable angina who have developed disabling angina despite maximal noninvasive therapy, when surgery can be performed with acceptable risk. If the angina is not typical, objective evidence of ischemia should be obtained. *(Level of Evidence: B)*

Class IIa

1. CABG is reasonable in patients with stable angina who have proximal LAD stenosis with 1-vessel disease. (This recommendation becomes Class I if extensive ischemia is documented by noninvasive study and/or LVEF is less than 0.50.) *(Level of Evidence: A)*
2. CABG may be useful for patients with stable angina who have 1- or 2-vessel CAD without significant proximal LAD stenosis but who have a moderate area of viable myocardium and demonstrable ischemia on noninvasive testing. *(Level of Evidence: B)*

Class III

1. CABG is not recommended for patients with stable angina who have 1- or 2-vessel disease not involving significant proximal LAD stenosis, patients who have mild symptoms that are unlikely due to myocardial ischemia, or patients who have not received an adequate trial of medical therapy and the following:
   a. Have only a small area of viable myocardium *(Level of Evidence: B)* or
   b. Have no demonstrable ischemia on noninvasive testing. *(Level of Evidence: B)*
2. CABG is not recommended for patients with stable angina who have borderline coronary stenoses (50% to 60% diameter in locations other than the left main coronary artery) and no demonstrable ischemia on noninvasive testing. *(Level of Evidence: B)*
3. CABG is not recommended for patients with stable angina who have insignificant coronary stenosis (less than 50% diameter reduction). *(Level of Evidence: B)*

9.2.3. Unstable Angina/Non–ST-Segment Elevation MI

Class I

1. CABG should be performed for patients with unstable angina/non–ST-segment elevation MI with significant left main coronary artery stenosis. *(Level of Evidence: A)*
2. CABG should be performed for patients with unstable angina/non–ST-segment elevation MI who have left main equivalent: significant (greater than or equal to 70%) stenosis of the proximal LAD and proximal left circumflex artery. *(Level of Evidence: A)*
3. CABG is recommended for unstable angina/non–ST-segment elevation MI in patients in whom revascularization is not optimal or possible and who have ongoing ischemia not responsive to maximal nonsurgical therapy. *(Level of Evidence: B)*

Class IIa

1. CABG is probably indicated in patients with unstable angina/non–ST-segment elevation MI who have proximal LAD stenosis with 1- or 2-vessel disease. *(Level of Evidence: A)*

Class IIb

1. CABG may be considered for patients with unstable angina/non–ST-segment elevation MI who have 1- or 2-vessel disease not involving the proximal LAD when percutaneous revascularization is not optimal or possible. (If there is a large area of viable myocardium and high-risk criteria are met on noninvasive testing, this recommendation becomes Class I.) *(Level of Evidence: B)*

9.2.4. ST-Segment Elevation MI (STEMI)

Class I

1. Emergency or urgent CABG in patients with STEMI should be undertaken in the following circumstances:
   a. Failed angioplasty with persistent pain or hemodynamic instability in patients with coronary anatomy suitable for surgery. *(Level of Evidence: B)*
   b. Persistent or recurrent ischemia refractory to medical therapy in patients who have coronary anatomy suitable for surgery, who have a significant area of myocardium at risk, and who are not candidates for PCI *(Level of Evidence: B)*
   c. At the time of surgical repair of postinfarction ventricular septal rupture or mitral valve insufficiency. *(Level of Evidence: B)*
   d. Cardiogenic shock in patients less than 75 years old with ST-segment elevation or left bundle-branch block or posterior MI who develop shock within 36 hours of MI and are suitable for revascularization

that can be performed within 18 hours of shock, unless further support is futile because of the patient's wishes or contraindications/unsuitability for further invasive care. *(Level of Evidence: A)*

e. Life-threatening ventricular arrhythmias in the presence of greater than or equal to 50% left main stenosis and/or triple-vessel disease. *(Level of Evidence: B)*

Class IIa

1. CABG may be performed as primary reperfusion in patients who have suitable anatomy and who are not candidates for or who have had failed fibrinolysis/PCI and who are not in the early hours (6 to 12 hours) of evolving STEMI *(Level of Evidence: B)*
2. In patients who have had an ST-segment elevation MI or non–ST-segment elevation MI, CABG mortality is elevated for the first 3 to 7 days after infarction, and the benefit of revascularization must be balanced against this increased risk. Beyond 7 days after infarction, the criteria for revascularization described in previous sections are applicable. *(Level of Evidence: B)*

Class III

1. Emergency CABG should not be performed in patients with persistent angina and a small area of myocardium at risk who are hemodynamically stable. *(Level of Evidence: C)*
2. Emergency CABG should not be performed in patients with successful epicardial reperfusion but unsuccessful microvascular reperfusion. *(Level of Evidence: C)*

9.2.5. Poor LV Function

Class I

1. CABG should be performed in patients with poor LV function who have significant left main coronary artery stenosis. *(Level of Evidence: B)*
2. CABG should be performed in patients with poor LV function who have left main equivalent: significant (greater than or equal to 70%) stenosis of the proximal LAD and proximal left circumflex artery. *(Level of Evidence: B)*
3. CABG should be performed in patients with poor LV function who have proximal LAD stenosis with 2- or 3-vessel disease. *(Level of Evidence: B)*

Class IIa

1. CABG may be performed in patients with poor LV function with significant viable noncontracting, revascularizable myocardium and without any of the above anatomic patterns. *(Level of Evidence: B)*

Class III

1. CABG should not be performed in patients with poor LV function without evidence of intermittent ischemia and without evidence of significant revascularizable viable myocardium. *(Level of Evidence: B)*

9.2.6. Life-Threatening Ventricular Arrhythmias

Class I

1. CABG should be performed in patients with life-threatening ventricular arrhythmias caused by left main coronary artery stenosis. *(Level of Evidence: B)*
2. CABG should be performed in patients with life-threatening ventricular arrhythmias caused by 3-vessel coronary disease. *(Level of Evidence: B)*

Class IIa

1. CABG is reasonable in bypassable 1- or 2-vessel disease causing life-threatening ventricular arrhythmias. (This becomes a Class I recommendation if the arrhythmia is resuscitated sudden cardiac death or sustained ventricular tachycardia.) *(Level of Evidence: B)*
2. CABG is reasonable in life-threatening ventricular arrhythmias caused by proximal LAD disease with 1- or 2-vessel disease. (This becomes a Class I recommendation if the arrhythmia is resuscitated sudden cardiac death or sustained ventricular tachycardia.) *(Level of Evidence: B)*

Class III

1. CABG is not recommended in ventricular tachycardia with scar and no evidence of ischemia. *(Level of Evidence: B)*

9.2.7. CABG After Failed PTCA

Class I

1. CABG should be performed after failed percutaneous transluminal coronary angioplasty (PTCA) in the presence of ongoing ischemia or threatened occlusion with significant myocardium at risk. *(Level of Evidence: B)*
2. CABG should be performed after failed PTCA for hemodynamic compromise. *(Level of Evidence: B)*

Class IIa

1. CABG is reasonable after failed PTCA for a foreign body in crucial anatomic position. *(Level of Evidence: C)*
2. CABG can be beneficial after failed PTCA for hemodynamic compromise in patients with impairment of the coagulation system and without previous sternotomy. *(Level of Evidence: C)*

Class IIb

1. CABG can be considered after failed PTCA for hemodynamic compromise in patients with impairment of the coagulation system and with previous sternotomy. *(Level of Evidence: C)*

Class III

1. CABG is not recommended after failed PTCA in the absence of ischemia. *(Level of Evidence: C)*
2. CABG is not recommended after failed PTCA with inability to revascularize due to target anatomy or no-reflow state. *(Level of Evidence: C)*

9.2.8. Patients With Previous CABG

Class I

1. Coronary bypass should be performed in patients with prior CABG for disabling angina despite optimal nonsurgical therapy. (If the angina is not typical, then objective evidence of ischemia should be obtained.) *(Level of Evidence: B)*
2. Coronary bypass should be performed in patients with prior CABG without patent bypass grafts but with Class I indications for surgery for native-vessel

coronary artery disease (significant left main coronary stenosis, left main equivalent, 3-vessel disease). ***(Level of Evidence: B)***

Class IIa

1. **Coronary bypass is reasonable in patients with prior CABG and bypassable distal vessel(s) with a large area of threatened myocardium by noninvasive studies.** ***(Level of Evidence: B)***
2. **Coronary bypass is reasonable in patients with prior CABG if atherosclerotic vein grafts with stenoses greater than 50% supplying the LAD coronary artery or large areas of myocardium are present.** ***(Level of Evidence: B)***

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KEY WORD: ACC/AHA Guidelines ■ atherosclerosis ■ bypass ■ cardiopulmonary bypass ■ coronary disease ■ grafting ■ revascularization ■ surgery